IES Newsletter

Volume 3, Number 1
January - February 1986

Director's Note

This issue of the IES Newsletter features two activities of the Hubbard Brook Ecosystem Study (HBES) relating to Mirror Lake. The HBES is a multidisciplinary study of air-land-water interactions in the Hubbard Brook Valley within the White Mountains of New Hampshire. Both the Hubbard Brook Experimental Forest (operated and maintained by the U.S.D.A. Forest Service) and Mirror Lake are located in the 3300 hectare Valley and have been the object of intensive, long-term ecological study.

The HBES was initiated in 1963 by Dr. F.H. Bormann and myself in cooperation with Dr. R.S. Pierce of the Forest Service. Ongoing studies at Hubbard Brook of forestry practices, air pollution including acid rain and acid cloudwater, stream ecosystems and Mirror Lake are an important part of IES's research program. Funding for these studies is provided by the National Science Foundation and the Andrew W. Mellon Foundation.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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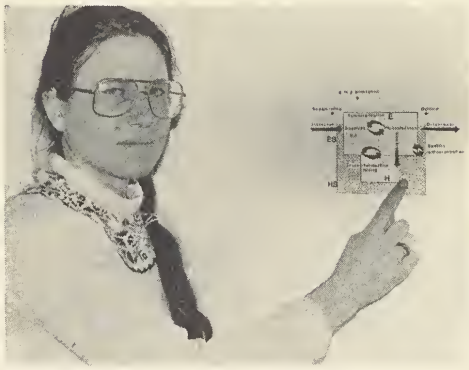
Mirror Lake: Grant for an In-depth Look

The Institute of Ecosystem Studies has been awarded $250,000 by the Ecosystem Studies Program of the National Science Foundation for the "Evaluation and Regulation of Nutrient Sources for Mirror Lake, New Hampshire". Principal investigators on this grant are Assistant Scientist Dr. Jonathan J. Cole and Institute Director Dr. Gene E. Likens. One of the newest Institute staff members who will be closely involved with the research is Postdoctoral Associate Dr. Nina Caraco (right) who recently received her Ph.D. from Boston University after doing a similar project at the Marine Biological Laboratory in Woods Hole, Massachusetts. Dr. Caraco will be working with Scott Nolan, a research assistant at the Institute, and Mark Mattson and Cliff Ochs, graduate students at Cornell University, on this two-year research project.

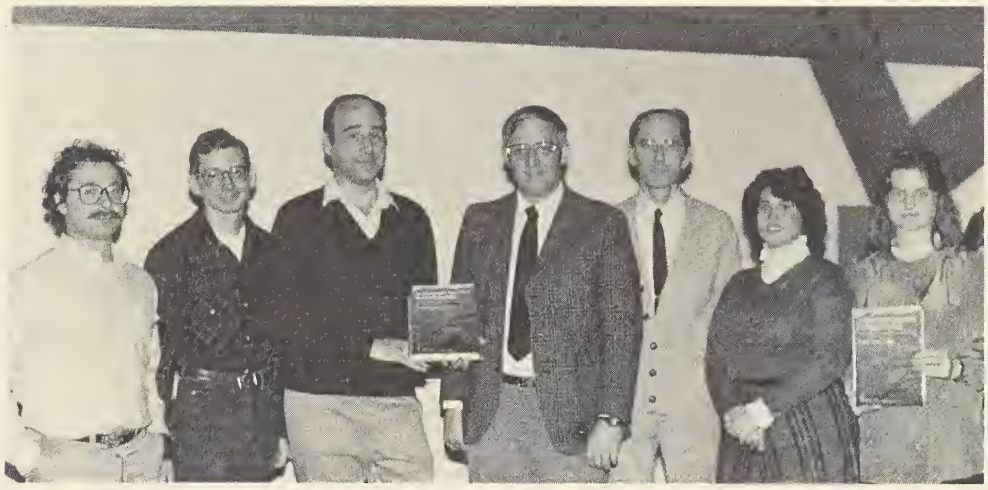


EMIL KELLER

The supply of nutrients (nitrogen and phosphorus) is perhaps the most important factor controlling the growth, or production, of phytoplankton (microscopic plant life suspended in the waters of lakes and oceans). Water bodies with high nitrogen and phosphorus tend to be eutrophic, or very productive. Although there has been much research on nitrogen and phosphorus inputs to lakes, there are very few studies which look at all of the important sources of nutrients for phytoplankton simultaneously. The researchers at IES have now been funded to start such a project at Mirror Lake.

Mirror Lake is a small, clear lake located in the town of West Thornton, New Hampshire. Its relatively pristine state makes it similar to thousands of remote lakes in the North Temperate Zone, but the location of many of those lakes would make their study difficult. Mirror Lake is located in the Hubbard Brook Valley, and laboratories of the Hubbard Brook Ecosystem Study provide an ideal base from which research can be done. The extensive background data on the lake and its watershed also contribute to its suitability as a research subject: the recently published volume, *An Ecosystem Approach to Aquatic Ecology: Mirror Lake and Its Environment* (see article below), was in fact used in planning the new research project.

Because of rapid human development in New Hampshire, it is likely that nutrient inputs to Mirror Lake will increase and will lead to greater phytoplankton productivity. The data collected in this project will be a valuable reference point for assessing the impact of any future changes in the lake's watershed.



EMIL KELLER

An Ecosystem Approach to Aquatic Ecology: Mirror Lake and Its Environment has recently been published, and editorial staff from Springer-Verlag New York, Inc. joined the Institute staff for a mid-December "book christening party" in the Plant Science Building. IES Director (and co-Principal Investigator on the Hubbard Brook Ecosystem Study) Gene E. Likens, IES Scientists Jonathan Cole, John Eaton and David Strayer, and HBES Executive Secretary Phyllis Likens were authors of the 516 page book, which is the third to deal with the long-term ecosystem research at the Hubbard Brook Experimental Forest in West Thornton, NH. Anyone wishing a copy of the book may contact Phyllis Likens at the Institute for details.

From left to right, above: J. Cole, D. Strayer, Springer-Verlag Science Editor Mark Licker, G.E. Likens, J. Eaton, P. Likens, and Springer-Verlag Editorial Assistant Sabine Kessler.

Fixing Nitrogen in a Sea of Sulfate

by Jonathan J. Cole
Assistant Scientist

Plants require many nutrients for growth. The nutrient that is least available relative to its demand is often called a "growth-limiting" nutrient. Adding this limiting nutrient will stimulate growth. In forests and in the ocean, nitrogen is usually the major limiting nutrient. Green plants in these ecosystems, for example trees and most algae, may use a variety of forms of nitrogen (ammonium, nitrate, organic) but cannot use nitrogen gas. Thus, although our atmosphere is roughly 80% nitrogen gas, this component is unavailable to most plants.

Certain blue-green algae and some bacteria have the ability to convert atmospheric nitrogen directly to ammonium. This process, called nitrogen fixation, is a critical part of the nitrogen cycle, making nitrogen available for use by other organisms.

Nitrogen is a growth-limiting nutrient despite the fact that some organisms can fix atmospheric nitrogen. It follows that some external factors control the rate or extent of the nitrogen fixation process. Nitrogen fixation requires energy as well as such elements as molybdenum and iron. Molybdenum, in fact, is required in three major processes in the nitrogen cycle (Fig. 1); in the absence of molybdenum there simply would be no cycle at all.

Professor Robert Howarth, of Cornell University's Section of Ecology and Systematics, and I began several years ago to try to explain an obvious paradox in aquatic nutrient limitation. In fresh waters phosphorus is the major limiting nutrient, but, in the ocean, nitrogen is the limiting element. In fresh waters, the blue-green algae fix copious amounts of nitrogen and are rarely nitrogen-limited. In the ocean, nitrogen fixation is rare. We hypothesized that this paradox could be explained, in part, by a difference in the availability of molybdenum in fresh and salt waters. Although the concentration of molybdenum in the sea is greater than in freshwater, the availability of molybdenum is actually much lower in the sea. This lower availability is due to the unusual chemical behavior of molybdenum. Molybdate, the only stable form of molybdenum in oxygenated water, is chemically almost identical to sulfate. Sulfate is the second most abundant negatively charged molecule in seawater and is typically more than 500 times more concentrated in seawater than in freshwater. We hypothesized that the organisms trying to take up molybdenum literally cannot find it in a sea of sulfate.

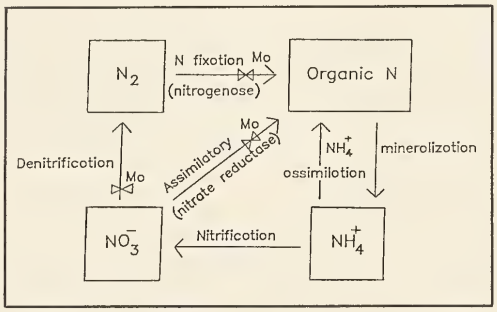


Diagram of the nitrogen cycle. The boxes represent the major forms of nitrogen. The arrows designate processes that transform one form of nitrogen into another (N_2 = nitrogen gas; NO^-_3 = nitrate; NH^+_4 = ammonium. The "bow-tie" symbols mark processes that are known to have an absolute requirement for molybdenum. Note that in the absence of molybdenum there would be no nitrogen cycle at all. (Source: Cole et al., Biogeochemistry, *in press.)*

With Research Assistants Scott Nolan at IES and Roxanne Marino and Judy Lane at Cornell University, we have been testing our hypothesis. The experiments have involved using radioactive molybdenum to directly measure molybdate uptake and the effect of sulfate. We have made a series of nitrogen fixation measurements in the Baltic Sea because that Sea goes from essentially freshwater (low sulfate) at its northern end to full strength seawater in the southwestern end. Additionally, we have been working with local lakes and with algal cultures in the Institute's laboratories. We have plans to visit some unusual saline lakes which have relatively high molybdenum in comparison to sulfate. Data from these experiments and research sites will help to clarify the nitrogen-molybdenum paradox, and thus lead to greater understanding of what controls the productivity in the world's lakes and oceans.

* * * * *

Dr. Jonathan J. Cole is an aquatic microbiologist, and has been assistant scientist at the Institute of Ecosystem Studies since 1983. His molybdenum research is funded by the Ecosystem Studies Program of the National Science Foundation.

On Winter Wildlife: The Red-Tailed Hawk

by Faye Rapoport
Communications Intern

Across the road from the Institute's Visitor and Education Center a single red-tailed hawk is spotted. Gliding silently through the winter sky, its eyes are focused intently on the field below. It has a graceful and dynamic presence, and it reminds us that the ecological balance is continually guarded by winter wildlife.

Buteo jamaicencis is a large, soaring hawk with broad wings, a fan-shaped red tail which is not always visible, and a light breast with dark streaks across the belly. The species breeds from Alaska and Canada to Panama and the West Indies, and the race "borealis" breeds in the New York area, where it is seen year-round. Red-tailed hawks generally take a lifetime mate, and hunt in habitual ranges. Their favored habitat is cultivated land and woodlots. The average lifespan is difficult to determine, but the *Audubon Society Encyclopedia of North American Birds* (1980) reports that "a captive female at Millbrook, N.Y., lived to 29 years old."

Birds of prey are frequently thought of as a nuisance, and the red-tailed hawk has not escaped this image. Actually, the birds can be useful to farmers: their prey includes meadow and white-footed mice, rats, and shrews. A much smaller portion of their diet includes rabbits, pheasants and smaller birds. Hawks and other predators are a natural form of pest control, and rarely disturb either humans or livestock.

The hawk population is, on the other hand, controlled by raccoons which eat eggs when they are left unguarded, by cold rains which can injure young birds, and by larger predatory birds like the great horned owl, which attack nestlings. Humans are responsible for at least one-half of the hawks' mortality, through shooting, nest destruction and trapping, as well as indirectly through plowing or lumbering which can ruin nests or cause desertion. As a result, the red-tailed hawk population has been declining steadily since World War II.

As human perception changes, birds of prey are more often seen as valuable and elegant forms of wildlife. This trend offers hope that, with less human interference and more concern for habitat preservation, the hawk population may be able to sustain itself in its ecological niche.

Staff

ALLEN ROKACH

Each December The New York Botanical Garden holds an awards ceremony honoring selected staff members for outstanding service. Institute of Ecosystem Studies' personnel honored for 1985 were, left to right,

Janice B. Claiborne, Assistant to the Director

Henry J. Behrens, Maintainer

Kathleen C. Weathers, Research Assistant II (cloudwater chemistry project)

Thomas J. Butler, Research Assistant II (MAP3S precipitation chemistry project)

Karen Budwill Moore, Research Assistant II (gypsy moth project)

Scott S. Nolan, Research Assistant I (molybdenum project)

Missing from the photo:

Donald C. Buso, Research Assistant II (Hubbard Brook Ecosystem Study)

New Staff

Two full-time scientists have recently joined the IES staff.

MICHAEL L. PACE, Aquatic Ecologist. The last to arrive of five new assistant scientists appointed in 1985, Dr. Michael L. Pace began his work at the Institute late in December.

Dr. Pace received his Ph.D. in Ecology at the University of Georgia and did his postdoctoral studies in Montreal at McGill

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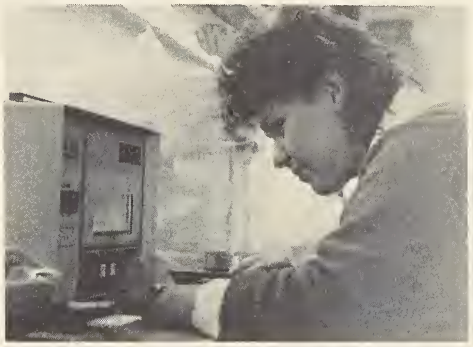
University's Limnology Research Center. For the past two-and-a-half years he was Assistant Professor of Oceanography at the University of Hawaii. There he taught undergraduate and graduate students and did research in marine ecosystems. His projects involved the vertical flux of materials in the ocean: the rates of transport of energy, nutrients and organisms from the surface to the deeper waters; and the fate of bacteria: how, and by what, are these single-celled microbes eaten, and are they an important source of energy in the ocean's food web?

Dr. Pace's long-standing interests in ecosystem studies and in working as part of a multidisciplinary group led him to IES. His research here will concern problems related to eutrophication in the Hudson River and in local lakes. He also plans to continue working on microbial ecology, investigating the fate of bacteria in lakes, streams and rivers in the Hudson Valley area.

DENISE SCHMIDT, Research Assistant II. Denise Schmidt earned her Master's Degree in Biological Science from Marshall University in Huntington, West Virginia in July 1985. In late January she began working with Manager of Laboratory Facilities John Eaton on the Hubbard Brook Ecosystem Study, and will be doing water chemistry analysis.



EMIL KELLER

Acid Rain Report

On September 24th, 1984 a group of scientists and others concerned with public policy met at the Institute of Ecosystem Studies to consider the role of scientific information in formulating policy for regulating acid deposition -- or what is commonly known as 'acid rain'. A sub-committee of scientists was formed to compile statements on key questions from six U.S. Government reports issued during the preceding four years, to determine the extent of scientific consensus on major aspects of acid deposition.

This report, "Is there scientific consensus on acid rain?", was released in October 1985 by the members of that committee: Dr. Charles T. Driscoll (Syracuse Univ.), Dr. James N. Galloway (Univ. of Virginia), Dr. James F. Hornig (Dartmouth College), Dr. Gene E. Likens (Institute of Ecosystem Studies, Millbrook), Dr. Michael Oppenheimer (Environmental Defense Fund, New York), Dr. Kenneth A. Rahn (Univ. of Rhode Island) and Dr. David W. Schindler (Freshwater Institute, Manitoba). The document reports that strong scientific

Gene and Phyllis Likens Attend Scientific Workshop in China

Institute of Ecosystem Studies Director Gene E. Likens and Phyllis Likens toured the People's Republic of China from October 22nd to November 22nd. As participants in a U.S.-China Air Pollution Ecological Effects Workshop, they traveled with a group of 24 other Americans including 15 plant ecologists and air pollution specialists. During a tour of 8 cities they visited scientific institutions, gave seminars on their research and met with Chinese environmental scientists.

Dr. Likens spent much of his time in discussion with Chinese scientists about the establishment of a cooperative research site in China for the collection of precipitation and cloud water samples for chemical analysis. He learned that not only does China have acid rain, but that the Chinese scientists are eager to participate in cooperative studies.

The Nanjing Bo
the sponsors of
Jia-Xi, a scientis
month hosting t

areas and back south. In addition to their work at Chinese research institutions, the group visited the Nanjing Botanical Garden, the South China Botanical Garden in Guangzhou, the Hangzhou Botanical Gardens, and, of course, the Great Wall.

Outside the Institute of Environmental Chemistry

ACID RAIN REPORT

(continued from page 3)

consensus does indeed exist on the major chemical, physical and biological issues. A cover letter accompanying the publication concludes by stating "we believe that (the six) governmental reports establish a scientific consensus that reducing the emissions of a large number of air pollutants, most notably sulfur dioxide, would benefit biological systems of North America significantly."

Copies of this report are being distributed to concerned parties nationwide and have been mailed to all members of the Mary Flagler Cary Arboretum. Other interested individuals may contact the Institute to request a copy.

EMIL KELLER

At the Greenhouse: *Thunbergia grandiflora*

Spring Calendar

COURSES

Course dates, lengths and fees vary. Some are part of longer certificate programs. Descriptions and registration information are highlighted in the current Education Program brochure; anyone wanting a copy may call to request one. Following is a list of spring courses:

Gardening Certificate
Insect Pests and Diseases of Plants
Growing and Using Herbs

Landscape Design Certificate
Landscape Design Theory
Landscape Design II: Plan Development
Drawing for Plan Presentation
Construction I: Grading and Drainage

Botany Certificate and Ecology Courses
Plant Ecology
Tree Identification
Spring Mushrooms
Edible Wild Plants Workshop
Field Botany: Local Flowering Plants

ECOLOGICAL EXCURSIONS

Garden in the Woods, Framingham, MA
- Date: May 15th, 1986
- Transportation: IES van
- Leader: Brad Roeller, Manager of Grounds and Display Gardens
- Deadline for registration: May 1st, 1986

Cape Cod Ecology and Whale Watch
- Date: May 30th - June 1st
- Transportation: Charter bus
- Accommodations: Provincetown Holiday Inn
- Leaders: Mark McDonnell, Plant Ecologist; Jill Cadwallader, Senior Staff Assistant
- Deadline for registration: April 18, 1986

SUNDAY PROGRAMS

Public programs are offered on the first and third Sundays of each month. All programs run from 2:00 - 4:00 pm and start at the Gifford House unless otherwise noted. They are open to everyone at no cost.

Tentative schedule (please call the number below to confirm the day's topic):

April 6th, Interpreting the landscape, A. Berkowitz
April 20th, The ecology of local streams, S. Findlay
May 4th, Plant lore and legend, E. Wolfson
May 18th, Introduction to and observation of kestrels, M. Fargione

SCIENTIFIC SEMINARS

The Institute's weekly program of scientific seminars features presentations by visiting scientists or Institute staff. All seminars take place in the Plant Science Building on Fridays at 3:30 p.m. Admission is free. For a schedule, contact Julie Morgan at (914) 677-5343.

ARBORETUM HOURS

Monday through Saturday, 9 a.m. to 4 p.m.; Sunday, 1-4 p.m. The Gift and Plant Shops are open Tuesday through Saturday 11 a.m. to 4 p.m.; Sunday 1-4 p.m. Closed on public holidays. All visitors must obtain a free permit at the Gifford House for access to the Arboretum. Roads closed to vehicles when snow covered.

MEMBERSHIP

Take out a membership in the Mary Flagler Cary Arboretum. Benefits include a special member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, free subscription to *Garden* (the beautifully illustrated magazine for the enterprising and inquisitive gardener), the IES Newsletter, and parking privileges and free admission to the Enid A. Haupt Conservatory at the New York Botanical Garden in the Bronx. Individual membership is $25; family membership is $35. For information on memberships, contact Janice Claiborne at (914) 677-5343.

For more information, call (914) 677-5359 weekdays from 8:30-4:30

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